Portable Gage for Pressure Ulcer Detection

Qi Wang, Linghua Kong, Stephen Sprigle & Vincent Hayward

McGill Centre for Intelligent Machines

catea Center for Assistive Technology and Environmental Access

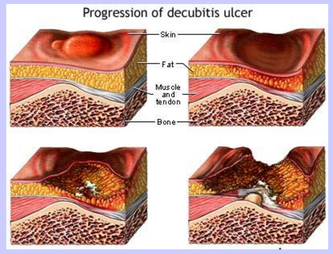
Georgia Tech

Abstract

A handheld instrument has been developed and tested that can detect subtle changes in the skin properties by measuring its biomechanical response. The portable and handheld design makes it suitable for the detection of stage-I pressure ulcers (bed sore), during which the biomechanical properties of the skin and subcutaneous tissue changes substantially.

Motivation

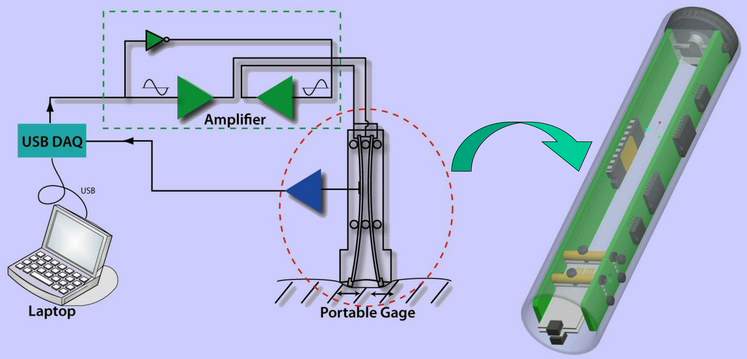
Pressure ulcers are widely considered to be a critical problem in rehabilitation since they can result in increased hospital stays and mortality, thereby increasing healthcare costs. Early detection of Stage-I pressure ulcers is critical because the skin is still intact and recovers well. A portable, inexpensive, and accurate gage for stage-I pressure ulcer detection would be helpful to patients who are at risk of pressure ulcer occurrence.



Adapted from http://www.nlm.nih.gov/medlineplus/ency/imagepages/19092.htm

Description

The portable stage-I pressure ulcer detection system consists of 4 components:

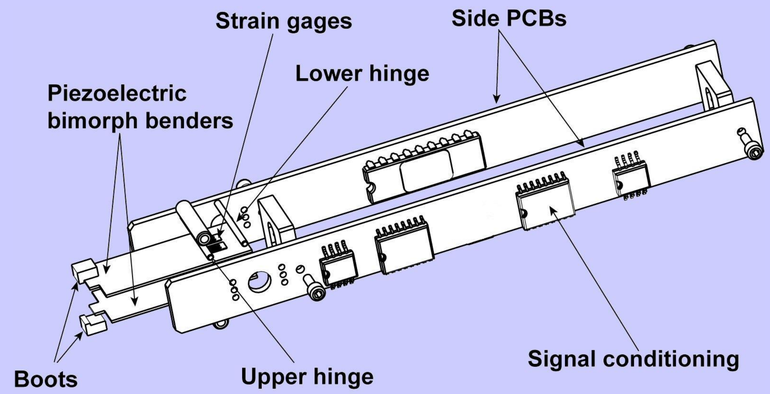


System diagram

Design

Two piezo bimorph benders were mounted between two side printed-circuit-boards (PCBs) to form a pair of tweezers to tangentially stretch the skin. The PCBs form a stiff box structure to firmly support mechanically the piezo actuators, and also host strain gage conditioning circuits. To measure the relative deflection of the benders, two dual grid strain gages were bonded on the each side of the benders.

The system is therefore inherently accurate since there is no sliding surface and since it works in differential mode electrically as well as mechanically.



Exploded view of the handheld gage

Experiments

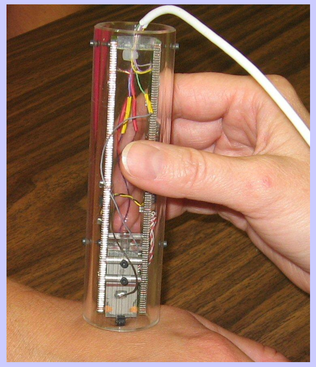
Preliminary experiments were conducted in which the elasticity and viscoelasticity of forearm skin and palm skin of human subjects were measured and compared.

- **Quasi-static stretch**

The excitation signal of the skin is a quasi-static ramp signal.

- **Sinusoidal loading**

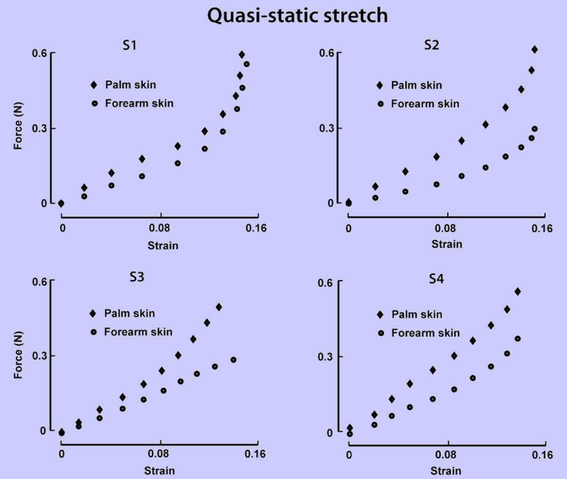
The excitation signal of the skin is a 10Hz sinusoid signal.



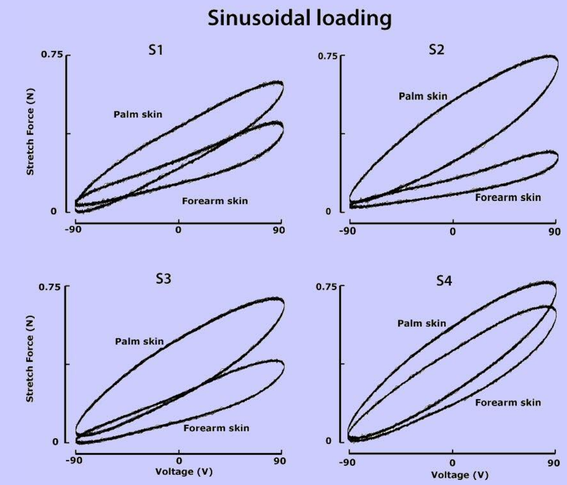
Experimental set-up

Preliminary Results

The results of quasi-static stretch are shown in the following figure, showing that the hairy skin was consistently softer than the glabrous skin.



The results of sinusoidal loading are shown below, suggesting that there were substantial differences in the viscoelastic parameters between the hairy and glabrous skin



Future Work

Future work involves extensive clinical testing of the device capabilities and designing the best excitation signals for detecting stage-I pressure ulcers.